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VOLUNTARY CLEANUP COMPLETION REPORT FOR THE SILVER SWAN MINE AREA RICO, COLORADO

Prepared for:

ARCO Environmental Remediation L.L.C.
307 E. Park Street, Suite 400
Anaconda, Montana 59711

Prepared by:

ESA Consultants Inc.
2637 Midpoint Drive, Suite F
Fort Collins, Colorado 80525

SEP 22 1999

September 17, 1999

CERTIFICATION OF COMPLETION

ESA Consultants Inc. ("ESA") hereby certifies that the voluntary cleanup of the **Silver Swan Mine Area, Rico, Colorado** has been fully and properly implemented in accordance with the cleanup plan approved on March 20, 1996 by the Colorado Department of Public Health and Environment.

ESA attests that it is fully qualified and has sufficient knowledge in this matter to so certify because ESA has been responsible for providing ARCO with both technical and permitting support since the beginning of the voluntary cleanup process. Specific activities completed by the ESA project team in support of voluntary cleanup plan development and implementation are summarized as follows:

1. Preparation of the approved voluntary cleanup plan application, as amended, which includes the ESA's statement of qualifications and the qualifications of individual contributors.

2. Design analysis, as necessary, to develop mine waste removal and containment approaches that provide adequate permanent protection of human health and the environment.

3. Development of detailed construction design drawings and specifications under the supervision of an ESA registered Professional Engineer.

4. Preparation of all permit applications required for voluntary cleanup construction.

5. Engineering services during construction: 1) inspections for conformance with design specifications, 2) development of design modifications to address special conditions encountered during construction, 3) fill compaction verification testing, and 4) confirmation soil sampling and analysis for verification of waste treatment (agricultural lime) application rates and waste removal.

6. Post-construction services: 1) assistance with the construction completion report, 2) surface water quality monitoring and reporting (2-year program), 3) annual site stabilization inspections, repair, and maintenance operations, 4) annual vegetation surveys, 5) annual reporting of stormwater permit compliance monitoring results and corrective actions taken, and 6) preparation of the approved construction stormwater permit inactivation request.

Edmund J. Schneider, P.G.
Vice President
ESA Consultants Inc.

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Voluntary Cleanup Completion Report
for the
Silver Swan Mine Area
Rico, Colorado

1.0 INTRODUCTION

1.1 General

This report provides, or incorporates by reference, evidence in support of the ARCO Environmental Remediation L.L.C. petition for a "No Further Action" determination, subsequent to completion of the voluntary cleanup of the Silver Swan Mine Area in Rico, Colorado. The voluntary cleanup plan for the Silver Swan Mine Area has been developed, approved, and fully implemented in accordance with the Colorado Voluntary Cleanup and Redevelopment Act.

Information included in this report is summarized as follows:

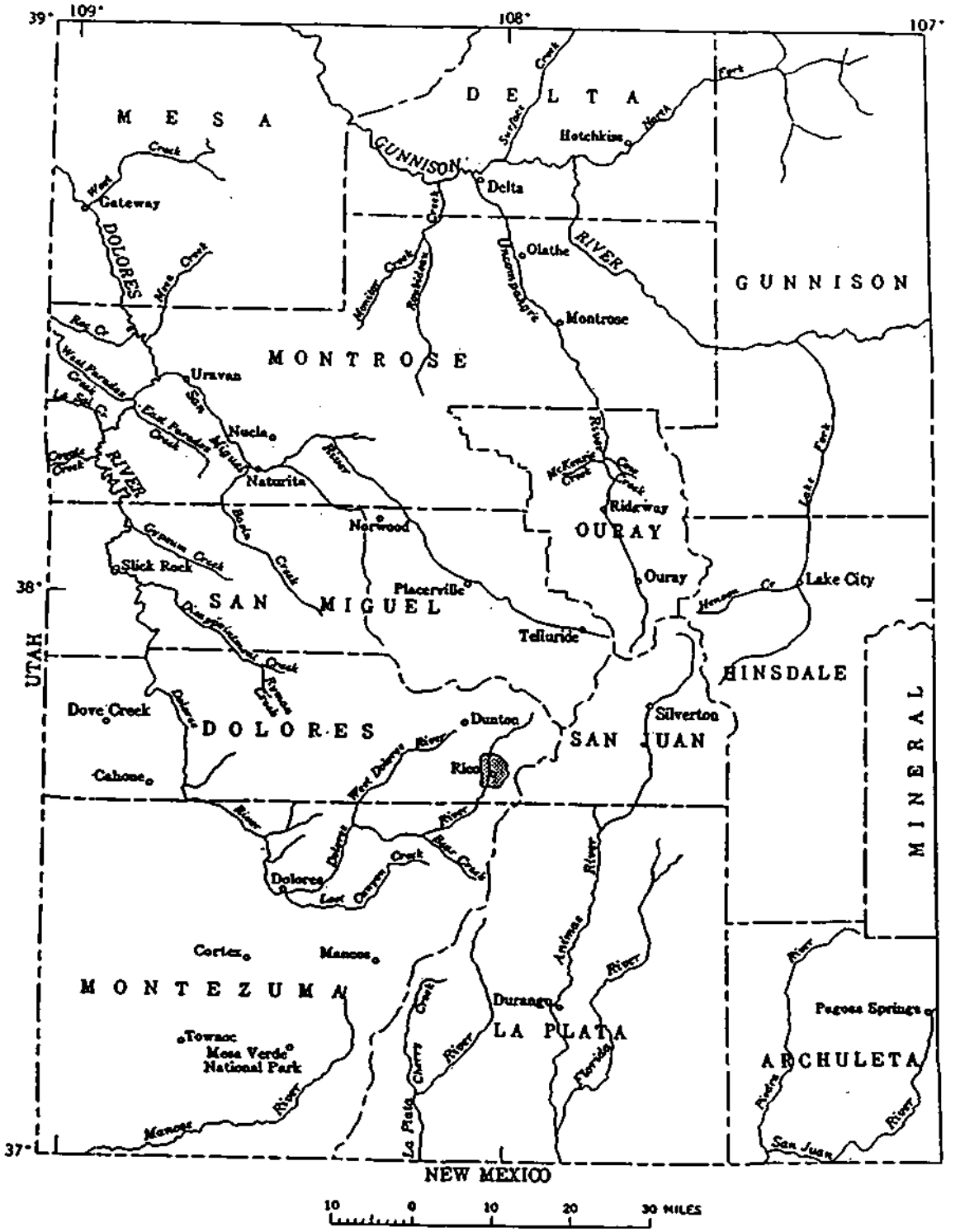
- References for a variety of voluntary cleanup plan implementation reports (e.g. construction completion, maintenance, and surface water quality monitoring program) previously submitted to the Colorado Department of Public Health and Environment ("Department").
- Summary of cleanup objectives, site conditions, issues, and engineered remedial measures.
- Summary of permits/approvals acquired for construction, compliance reports, and releases.
- Risk assessment based on the selected remedy for the designated land use of the site.

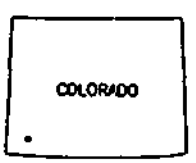
Figure 1-1 shows the location of Rico in southwestern Colorado. Figure 1-2 shows the location of the site within the Dolores River valley in the Town of Rico. Inactivation notice information for the Silver Swan Mine Area mining stormwater discharge general permit certification is provided in the Appendix.

1.2 Cleanup Plan Implementation Reports and Notices

The following documents previously submitted to the Department and incorporated herein by reference provide substantial evidence that ARCO has complied with the voluntary cleanup plan, as approved by the Department on March 20, 1996.

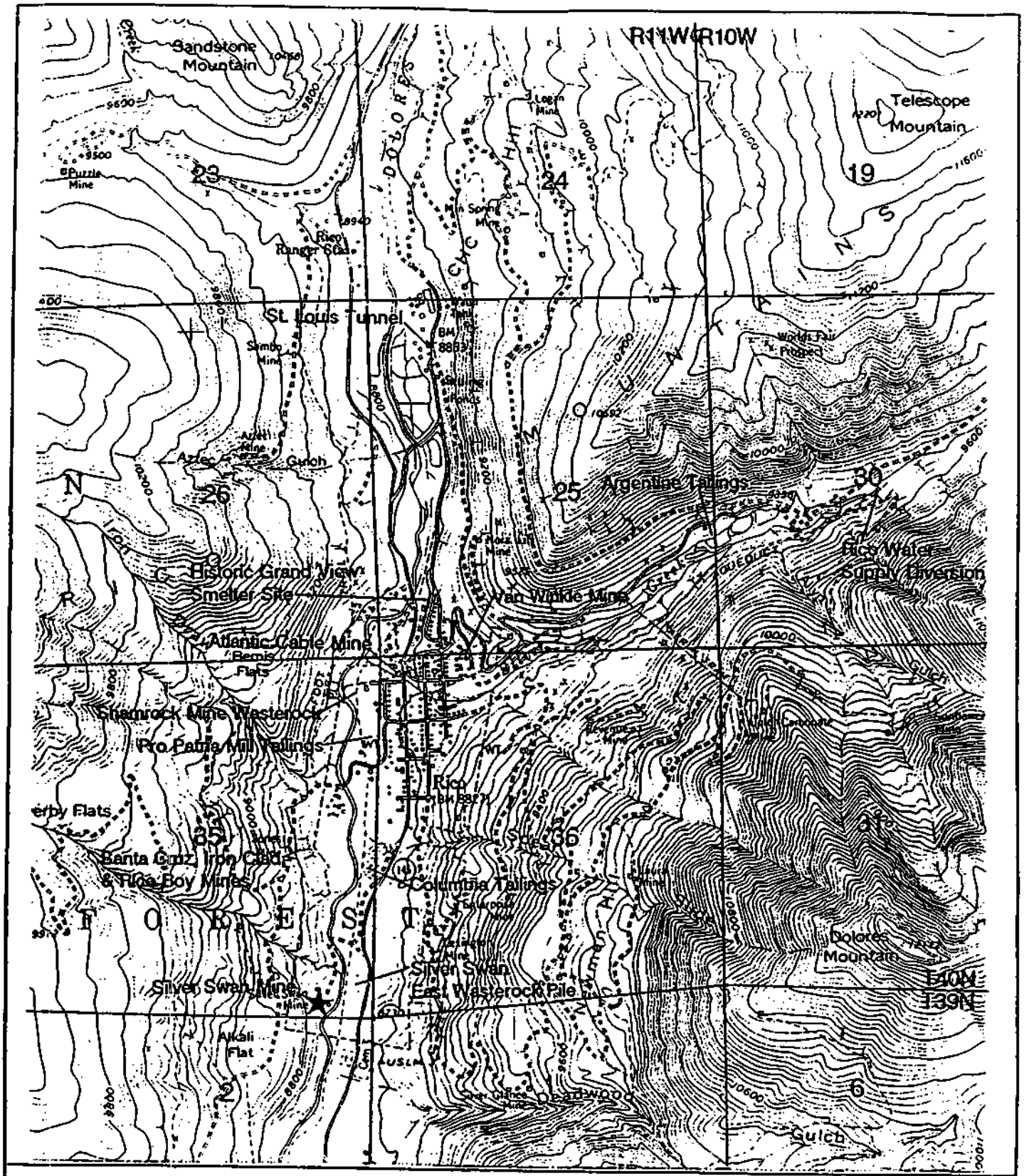
Voluntary Cleanup and Redevelopment Act Application for Silver Swan Mine Area, Rico, Colorado. February 13, 1996. Atlantic Richfield Company, Los Angeles and Rico Properties, L.L.C. Submitted to Colorado Department of Public Health and Environment, Denver.





RICO DISTRICT
LOCATION MAP

FIGURE 1-1



SILVER SWAN MINE
SITE LOCATION MAP

FIGURE 1-2

Section lines added.
Base Map: USGS Rico Quadrangle, Colorado, 7.5 Minute Series.

Rico Mining Area Construction Completion Report. January 1997. Atlantic Richfield Company, Los Angeles. Prepared by Anderson Engineering Co., Inc., Salt Lake City.

Rico Site Remediation Project 1997 Maintenance Completion Report. October 1997. ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants Inc., Fort Collins.

Rico Site Remediation Project Surface Water Monitoring Program Post-VCUP Interim Report. October 1997. ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants, Inc., Fort Collins.

Rico Site Remediation Project Surface Water Monitoring Program Post-VCUP Final Report. October 1998. ARCO Environmental Remediation, L.L.C., Los Angeles. Prepared by ESA Consultants, Inc., Fort Collins.

Rico Site Remediation Project 1998 Maintenance Completion Report. November 1998. ARCO Environmental Remediation L.L.C., Los Angeles. Prepared by ESA Consultants Inc., Fort Collins.

Inactivation Notice for Mining Stormwater Discharge Permit Certification No. COR-040191, with attached Technical Memorandum - Reclamation Monitoring Results for the Silver Swan Mine. ARCO Application to the CDHPE Water Quality Control Division, signed October 1, 1998.

Inactivation Approval- Stormwater Discharge Permit, effective February 2, 1999. Letter to ARCO from the Water Quality Control Division, dated February 9, 1999.

1.3 Cleanup Goal and Objectives

The goal of the approved voluntary cleanup plan for the historic mine area is to provide adequate protection of human health and the environment for the designated land use of the site. The essential objectives of the selected remedy addressed by the plan are to:

- Provide permanent solutions to eliminate or minimize, to the maximum extent practicable, the potential for release of mine waste constituents to surface and ground water systems.

- Prevent human ingestion of contaminated waste material in areas where inhalation of dust or direct contact could potentially pose an unacceptable health risk for the land use designated in the voluntary cleanup plan.

- Prevent any unnecessary disturbance of existing wetlands (which provide passive treatment of adit drainage) and the Dolores River during VCUP remedial activities.

2.0 SUMMARY OF PRE-CLEANUP SITE CONDITIONS AND ISSUES

Major conditions and issues addressed by the cleanup plan for the Silver Swan Mine Area include:

- Land ownership: One private property owner for five private land tracts
- Area: approximately 3.7 acres with contributory drainage basin area of about 76 acres; area includes mine adit, a main waste rock pile (2.0 acres), wetlands area (1.5 acres) and a small waste rock pile (0.2 acres on the east side of the Dolores River).
- Mine waste volume and type of potential contaminants: 15,000 c.y. of historic mineralized mine waste containing heavy metals (predominantly iron, lead, and zinc) with additional heavy metals derived from historic passive mine adit drainage
- Pre-VCUP land use: Undeveloped historic inactive mine site
- Future land use: Undeveloped historic inactive mine site
- Issues: 1) mine waste on river banks subject to floods; 2) incidental human contact with exposed waste; 3) water contact with waste from direct rainfall/snowmelt, runon, adit drainage onto waste, and wetland ponded against toe of waste pile; and 4) river corridor aesthetics

3.0 SUMMARY OF IMPLEMENTED REMEDY

3.1 Major Components of the Remedy

Major components of the implemented remedy for mine waste material and reclamation of the mine site include:

- Reclamation cover to eliminate direct human contact with mine waste considering the proposed future use of the property.
- Consolidation and stabilization of mine waste-left-in-place against earthquakes and wind and surface water erosion to prevent off-site dispersal of mine waste material.
- Runon, runoff, infiltration, and adit drainage controls to eliminate or minimize transport of soluble mine waste constituents to ground water and surface water receptors.
- Re-establishment of wetlands and flood plain plant communities in designated waste removal areas to reclaim vegetative habitat consistent with surrounding river corridor.

3.2 Waste Removal and Consolidation

The total area occupied by mine waste-left-in-place has been reduced from 2 acres to 1.5 acres through waste removal and consolidation. Engineered mine waste consolidation measures were implemented to reduce the total area of land containing waste-left-in-place within the Dolores River corridor and completely remove waste materials as non-point sources of potential pollution from selected areas. A buffer zone, 50 feet wide by 450 feet long, between the river channel and the consolidated waste pile has been created by the removal of all waste (7,000 c.y.) within the zone. The removal operation also included the relocation of an additional 400 c.y. of mine waste to the consolidated waste pile from the wetlands on the northeast side of the site and relocation of about 600 c.y. of waste rock from the east bank of the Dolores River to the Columbia Tailings voluntary cleanup site in Rico.

Verification of waste removal was accomplished through confirmation sampling and analysis of the underlying soil. Waste removal was considered complete, as described in the cleanup plan, after all waste material was confirmed by visual inspection and the soil sample analysis results indicated a zinc content of below or within the range of the natural background concentrations. Confirmation results are provided in the referenced construction completion report.

3.3 Hydrologic Controls

Engineered hydrologic controls for runon, runoff, infiltration, and flood protection have been constructed to permanently prevent or minimize water contact with waste material and achieve permanent containment of waste-left-in-place.

Waste pile surface re-configuration and reclamation cover. The reclaimed consolidated waste rock pile is graded, compacted, and protected by a reclamation cover for erosion protection and infiltration control. Compaction depth is 12 inches. The top surface is graded at 3 percent slope to the south to prevent ponding of surface water, safely shed site runoff, and minimize infiltration. Outslopes are graded to 3H:1V to increase slope stability against erosion and slumping. The reclamation cover is described below.

Surface water and adit drainage diversion structures. A 250-foot long diversion structure intercepts and re-routes runoff from the adjacent hillside away from the west side of the reconfigured waste pile. The structure is a combination of corrugated metal half pipe and a lined and riprapped trapezoidal ditch, sized to safely pass the estimated peak runoff from a 100-year design storm event. A lined and riprapped diversion ditch routes adit drainage away from the northwest and north sides of the waste pile and into the pre-existing wetlands. A control dike, 180-feet in length and 3-feet high, provides a buffer zone between a pre-existing wetlands pond and the north side of waste pile. The dike has increased the capacity of the pond for sedimentation control. A riprapped dike spillway structure allows for continued flow of adit drainage through the pond and wetlands between the pond and the Dolores River.

Dolores River flood protection revetment. About 400 feet of buried bedded riprap (775 c.y.) has been placed along the entire east edge and a portion of the northeast edge of the re-configured and consolidated waste pile. This riverside stabilization revetment is sized to protect

against the peak flow velocity, scour depth, and stage estimated for Dolores River 500-year design flood event with 2 feet of freeboard.

3.4 Reclamation Cover

A stabilizing reclamation cover was placed on the consolidated waste pile surface and all waste removal areas to provide permanent protection against wind and water erosion, infiltration control, protection against human and wildlife contact with waste materials, and enhancement of river corridor aesthetics. Components of the reclamation cover are summarized below.

Lime amendment. The top 12 inches of the waste pile has been treated with agricultural lime at an application rate of 25 tons/acre to neutralize potential acid generation. See construction completion report for application rate determination procedures and analysis results.

Growth medium. The treated surface of the waste pile is covered with 12 inches of clean borrow soil material. The waste removal area northeast of the waste rock pile is covered with 3 to 6 inches of processed (minus 3/4 inch) borrow soil material. A local source of soil borrow material free of mine waste and debris was developed for this site. The borrow area was closed and revegetated after completion of site cleanup.

Vegetation cover. Three different seed mixtures of native grasses and forbes (general upland mix, slope stabilization mix, and wetland planting mix) were used where appropriate to establish a protective vegetation cover on all disturbed areas. Fertilizer and hydromulch amendments were applied at the time of seeding to enhance plant establishment. Seed mixture and amendment application rates are provided in the construction completion report. The surface stability criterion proposed to the Department (Water Quality Control Division) under the stormwater discharge permit program was achievement of a minimum average cover of 50 percent combined plant and rock fragments.

Initial seeding of all disturbed areas designated for vegetative cover was completed during the second week of October 1996. Two annual revegetation inspections have been performed since construction completion, one in July 1997 and the other in September 1998 near the end of the growing season. Drought conditions in June 1997 prevented development of adequate plant cover on the waste pile during the first growing season. Consequently, the waste pile had to be reseeded, fertilized, and mulched in October 1997.

Quantitative results for the 1998 revegetation survey indicate a stable surface has been achieved on the reclaimed waste pile and removal areas. The reclaimed waste pile and buffer zone plant cover averaged about 34 percent (range of 29 to 42 percent) and the rock fragment cover averaged about 35 percent (range of 24 to 44 percent), resulting in a total average surface cover of about 69 percent. The reclaimed wetlands area plant cover averaged about 59 percent (range of 36 to 91 percent) and the rock fragment cover averaged about 24 percent (range of 0 to 53 percent), resulting in a total average surface cover of about 83 percent.

4.0 CONSTRUCTION/ACCESS PERMITS AND RELEASES

4.1 Permits

The following listed permits were obtained by ARCO as required to implement the approved voluntary cleanup plan. No other approvals were required to implement the plan.

- Stormwater Discharge Permit, CDPS Permit No. COR-040191; request for termination approved by the CDPHE and permit inactivated effective February 2, 1999.

- Corps of Engineers Nationwide General Permit No. 38, Cleanup of Hazardous and Toxic Wastes; expiration date was January 21, 1997.

4.2 Inactivation of Silver Swan Mine Area Stormwater Discharge Permit

As noted above, the stormwater discharge permit has been terminated based on the plant and rock fragment cover achieved, observed stability of the site surface, and the construction of other permanent hydrologic control structures. The Technical Memorandum describing the reclamation results for the site, as submitted with ARCO's request for termination of the stormwater discharge permit, is provided in the Appendix.

5.0 RISK ASSESSMENT

A key consideration in assessing risk associated with reclaimed consolidated mine waste left-in-place at the Silver Swan Mine Area is the extent of human or environmental exposure when the property is used for the purposes identified in the approved voluntary cleanup plan (undeveloped inactive mine site). Completion of the voluntary cleanup has achieved reduction of risk to human health and the environment through the following:

- Removal of contaminated mine waste from wetlands and the banks of the Dolores River, and remediation of consolidated waste-left-in-place minimizes human and environmental exposure pathways.

- Stabilization of contaminated waste-left-in-place provides long-term minimization of human and environmental exposure pathways.

- Control of access and covering of exposed contaminated mine waste prevents direct human contact and minimizes human exposure pathways.

To assure the protection of human health, and to protect against environmental releases, effective closure of mine waste left-in-place has been achieved by waste consolidation and construction of several permanent and durable non-point source waste containment measures. For long-term effectiveness, emphasis was placed on "passive-care" approaches. These measures prevent direct human contact and provide long-term control of major contaminant migration pathways, including wind and surface water erosion, contaminated surface water runoff, and infiltration and seepage. Consequently, these measures eliminate or effectively reduce potential mine waste impacts

to: 1) the beneficial uses of the waters of the State, 2) surrounding ecosystems, and 3) human health due to adsorption, ingestion, and/or inhalation of waste particles.

In addition, post-remediation monitoring and maintenance activities provide evidence that the properties, when used for the purposes identified in the cleanup plan, are protective of human health and the environment. Results of annual site stabilization inspections required under the Department's stormwater discharge permit program verified that the structural measures (such as flood protection, drainage diversion structures, and waste pile reconfiguration) are functioning as designed. In particular, the release of contaminated seepage and surface runoff from the waste pile due to mine drainage has been effectively eliminated by the diversion of mine drainage away from the reclaimed waste pile.

Results of the annual inspections have also verified the stability of the surface cover. Proposed surface stability criterion for adequate plant and rock fragment cover protection of the reclaimed mine waste pile and waste removal areas were achieved by the end second growing season. The proposed stability criterion were approved by the Department (Water Quality Control Division) under the stormwater discharge permit program. As discussed above, achievement of adequate site stability has resulted in the inactivation of the stormwater discharge permit (see Appendix).

Pre- and post-remediation surface water quality monitoring results support evidence from the annual site stabilization inspections that the properties remain protective of human health and the environment. Monitoring results indicate that dissolved metals loads from the Silver Swan Mine Area wetlands drainage do not impact beneficial uses of the Dolores River. Concentrations of selected dissolved metals in the Dolores River downstream of the Silver Swan Mine Area continue to be consistently below cold water aquatic life standards.

In addition to the implemented remedial measures, site accessibility constraints further reduce potential human health risk by limiting the opportunity for direct human contact. The property remains inaccessible from the east by road and there are no pedestrian bridges across the river. An unimproved dirt road on the west side of the valley provides access to the property from the north through the reclaimed Santa Cruz mine area. However, a security gate across the Santa Cruz access road also controls vehicle access to the Silver Swan Mine Area.

APPENDIX

INACTIVATION STORMWATER DISCHARGE PERMIT

STATE OF COLORADO

Bill Owens, Governor
Jane E. Norton, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
Located in Glendale, Colorado

Laboratory and Radiation Services Division
8100 Lowry Blvd.
Denver CO 80220-6928
(303) 692-3090

http://www.cdphe.state.co.us

Colorado Department
of Public Health
and Environment

February 9, 1999

Atlantic Richfield Company
ATTN: Chuck Stilwell
307 E. Park Street, Suite 400
Anaconda, MT 59711

Re: Inactivation - Stormwater Discharge Permit
Silver Swan Mine
CDPS Permit No. COR-040191
Dolores County

Dear Mr. Stilwell:

This office has reviewed your request for termination of the above-referenced permit. You have certified that your site has been stabilized. It is our opinion that this site does not require a stormwater discharge permit at this time. Your permit has been inactivated effective February 2, 1999.

We have prorated your annual fee pursuant to Section 6.16.(5)(A)(B) of the Permit Regulations which state:

> "Once the Division proceeds to terminate a permit at the permittee's request, the prorated fee shall apply to the period of time the permit has been in effect including, but not exceeding, ninety (90) days from the date the permit termination request is received by the Division."

Your prorated amount for the 1998-1999 annual administrative fee is $31.00 which covers the period July 1, 1998 through February 2, 1999. A refund in the amount of $22.00 is being sent under separate cover.

If you have any questions about the fee or the inactivation, please contact me at (303) 692-3503.

Sincerely,

Charlene Montgomery
Administrative Assistant
WATER QUALITY CONTROL DIVISION

cc: Ed Schneider, ESA Consultants, 2637 Midpoint Dr., Ste. F, Ft. Collins, CO 80525-4415
Local Health Department
File

/cm

Colorado Department of Public Health & Environment
Water Quality Control Division
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

FOR AGENCY USE ONLY			
rec			
eff			
	Year	Month	Day

INACTIVATION NOTICE FOR

MINING STORMWATER DISCHARGE GENERAL PERMIT CERTIFICATION

Please print or type. Form must be filled out completely.

Certification Number: COR-04 0 1 9 1 Taxpayer ID or EIN 954609777
–OR– COG-50 _ _ _ _

Permittee (Company) Name: Atlantic Richfield Company

Permittee Address: ARCO Environmental Remediation
444 South Flower Street
Los Angeles, CA 90071 Phone No. (213) 486-8309

Mine/Facility Name: Silver Swan Mine

Mining Site Address/Location: Highway 145, Rico

County: Dolores Contact Person: David M. Romero

Reason/justification for inactivation, and description of final site stabilization. (Attach any supporting documentation, such as proof of Mined Land Reclamation Board bond release): Voluntary remediation of this inactive mine waste pile was completed in October 1996. The attached Technical memoranda provides a summary of site characteristics, permanent remedial measures, reclamation results, and proposed success criteria revision for this site.

I certify under penalty of law that by the date of my signature below, all disturbed soils at the identified mining site have been finally stabilized; all temporary erosion and sediment control measures have been removed; all mining and equipment maintenance waste have been disposed of properly; and all elements of the Stormwater Management Plan have been completed.

I understand that by submitting this notice of inactivation, I am no longer authorized to discharge stormwater associated with mining activity by the general permit. I understand that discharging pollutants in stormwater associated with mining activities to the waters of the State of Colorado, where such discharges are not authorized by a CDPS permit, is unlawful under the Colorado Water Quality Control Act and the Clean Water Act.

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (See 18 U.S.C 1001 and 33 U.S.C. 1319.)

David Romero 10/1/98
Signature of Permit Applicant (Legally Responsible Party) Date Signed

David M. Romero Project Manager
Name (printed) Title

9/97/mn/in

TECHNICAL MEMORANDUM

RECLAMATION MONITORING RESULTS FOR THE SILVER SWAN MINE

Mining Stormwater Discharge General Permit Certification No.: COR-040191

September 16, 1998

Introduction

The historic, inactive Silver Swan Mine is one of eight sites for which a Colorado Stormwater Discharge Permit was issued to Atlantic Richfield Company (ARCO) in association with five approved Voluntary Cleanup Plans (VCUPs) implemented in and near the Town of Rico under the Voluntary Cleanup and Redevelopment Act (VCRA). Environmental baseline field work associated with this project was begun in the Spring of 1995, followed by engineering and reclamation planning activities. Mine waste remediation construction work was completed in 1996. The first annual revegetation inspection was completed in July 1997, in a qualitative manner, and remedial measures recommended. Remedial measures were completed by October 1997. On September 9, 1998 the second annual revegetation inspection of this site was completed and quantitative vegetation cover data collected by Cedar Creek Associates, Inc.

The following paragraphs detail the overall characteristics of the Silver Swan Mine and the results of the reclamation monitoring activities. The VCUP for this inactive mine waste site is described in the document *Voluntary Cleanup and Redevelopment Act Application for Silver Swan Mine Area-Rico, Colorado* submitted in February 1996 to the Colorado Department of Public Health and Environment by Atlantic Richfield Company, et al. Remedial measures completed in 1997 are described in the document *Rico Site Remediation Project-1997 Maintenance Completion Report* submitted in October 1997 to ARCO Environmental Remediation L.L.C. by ESA Consultants, Inc.

General Site Characteristics and Site Remediation History

Original Disturbed Area: 3.7 acres with maximum sideslope angles of ~ 33 percent.

Original Material Composition: Pyritic waste rock material with low pH values (4.1 to 6.6) and Acid-Base Potential values (based on pyritic sulfur) of -37 tons of $CaCO_3$/1,000 tons of material.

1996 Remediation Summary: Consolidate outlying waste material (~ 12,600 cubic yards) with main waste pile and grade to engineering specifications; complete runon and infiltration controls; amend top 12 inches of the waste surface with liming material; apply 12 inches of cover (borrow) soil (~1,600 cu. yds.); complete revegetation sequence (seedbed preparation, fertilization, seeding, mulching). All soil disturbing activities at the site were completed in September 1996.

Results of July 1997 Qualitative Monitoring: Revegetation success limited; no exposed waste material observed; level surface stable; all slopes exhibited rilling with west slope having shallow gullies; <1 to 15 percent vegetation cover estimated visually with 45 to 50 percent surficial coarse fragment cover.

Remedial Measures Recommended in 1997: Repair rills and gullies, fertilize, reseed, and mulch 1 acre of this site for which revegetation had not achieved the desired results at the end of the first growing season. The suggested remedial measures were completed in early October 1997.

Results of 1998 Quantitative Monitoring

Revegetation monitoring at the Silver Swan Mine was completed on September 8, 1998. As requested in the permit issued by the Colorado Department of Public Health and Environment, vegetation cover was measured to determine whether existing surficial conditions warrant the termination of this permit following two growing seasons. The revegetated area was divided into two reclaimed vegetation types based upon the species which had been planted and become established. These two types include the "wetland" type located on the nearly level graded areas located near the ponds in the northern portion of the disturbed area and the "upland" type located primarily on the graded waste pile slopes.

Cover for both vegetation types was measured using the "point-intercept" methodology. A lazer-powered "Optical-Point Bar" developed by Cedar Creek Associates, Inc. was employed to gather the plant cover data. To complete data collection, five ten-meter transects were located in areas selected as representative of plant cover across this 3.7 acre site. Point-intercept data was collected at 0.1-meter intervals along each 10 meter transect such that 100 data points were collected per transect. Each data point could represent a bare ground, litter, rock (coarse fragments > 2 mm. in size) or vegetation "hit". Vegetation hits were recorded by species or genus where a plant could not be identified to species level. A total of 500 data points were collected at the Silver Swan Mine. Achieving statistical adequacy was not considered to be necessary as per the termination criteria specified in the stormwater permit issued.

Plant cover across the five transects traversed in the wetland vegetation type ranged from 36.0 to 91.0 percent with an average of 58.6 percent. The dominant species identified along the transects was *Agrostis alba* (redtop). Thirteen additional species were also found along the transects or were recorded as incidental species in this constructed wetland. These species included grass, forb, and shrub life-forms, represented by such species as *Agropyron dasystachyum* (thickspike wheatgrass), *Melilotus officinalis* (yellow sweetclover), and a *Salix* (willow). The percent of surface covered by rock fragments ranged from 0.0 to 53.0 percent with an average of 24.4 percent. Litter, bare ground, and open water averaged 7.8, 6.4, and 2.8 percent, respectively.

Across the five transects located in the upland vegetation type, plant cover ranged from 29.0 to 42.0 percent with an average of 33.8 percent. The dominant species identified along the transects were

Bromus carinatus (mountain brome) and *Agropyron trachycaulum* (slender wheatgrass). Twenty-nine additional species were also found along the transects or were recorded as incidental species over the graded slopes. These species included grass and forb life-forms, represented by such species as *Agropyron dasystachyum* (thickspike wheatgrass) and *Penstemon strictus* (Rocky Mountain penstemon). The percent of surface covered by rock fragments ranged from 24.0 to 44.0 percent with an average of 34.8 percent. Litter, bare ground, and mulch cover averaged 2.8, 25.0, and 3.6 percent, respectively.

A copy of the plant cover data sheet completed in the field is included at the end of this Technical Memorandum, as are two representative photographs taken of the site during the field monitoring work.

Monitoring Data Summary and Proposed Vegetative Cover Criterion Revision

Across five representative transects traversed in the upland vegetation type, surface cover by plants and rock fragments averaged 33.8 and 34.8 percent, respectively. Together, plants and rock fragments covered an average of 68.6 percent of the revegetated slopes of the Silver Swan Mine. No rilling or gullying was observed anywhere on this site during the 1998 monitoring field work. Minor sheet erosion is assumed to have occurred over the sloping portion of this site but there is no evidence of soil accumulation at the toe of the constructed slopes. In the constructed wetland, surface cover by plants and rock fragments averaged 58.6 and 24.4 percent, respectively. Plants and rock fragments combined covered an average of 83.0 percent of the revegetated surface.

The stormwater permit termination criteria for vegetation cover requires that "vegetation has been established with an average cover or density, over the previously disturbed area, of a minimum of 40 percent vegetative cover or 70 percent of the vegetative cover of a similar undisturbed site, which ever is higher....." The permit goes on to say that the Division may "after consultation with the permittee and upon good cause being shown, revise the cover requirement on a case-by-case basis".

ARCO requests that the revegetation criteria applicable to this site be revised to reflect the surficial conditions at the site and the materials making up the seedbed, growth media, and substrate materials. To require that the average vegetation cover values be compared to the vegetative cover of an undisturbed similar site would not be appropriate. There are no similar undisturbed sites which are underlain at 12 inches with amended pyritic waste rock which is, in turn, underlain with graded pyritic waste rock as is the case for the graded slopes at this site. The only undisturbed upland herbaceous vegetation communities known to exist in the area are mountain meadow communities which are typically underlain with more than 24 inches of quality soil material. Thus, a comparison with undisturbed meadow soils may not be appropriate.

A requirement of a minimum of 40 percent cover could be appropriate under general circumstances though this criteria does not take into account the affect of the high surface rock fragment cover percentages typical of this site in upland areas. Both vegetation and surficial rock fragment cover will aid in stabilizing the graded surface and reducing long-term erodibility. In the case of the graded waste rock slopes, vegetation/surficial rock fragment cover ranges from 59.0 to 75.0 percent with an average of 68.6 percent. Given that no rills or gullies were found on site and that sheet erosion was minimal following two growing seasons, it seems appropriate to conclude that this site is stable, particularly considering that the angle characterizing all graded slopes is no greater than approximately 33 percent. The constructed wetland area meets the 40 percent vegetation criterion but would none-the-less be considered stable in its own right, given the nearly level slope and wet soil conditions which render this area resistant to erosion.

A request to revise the applicable criteria was submitted to the Colorado Department of Public Health and Environment at the time of permit application submittal in 1996. The criterion proposed by ARCO was to achieve a minimum average cover of 50 percent by plants and rock fragments, combined, so long as such resulted in a stable surface. The agency personnel contacted in 1996 were receptive to this change, considering the characteristics of the project site and the materials which would form the final plant growth media, but deferred to accept such a criterion change until the time of proposed permit termination in 1998.

Other Significant Hydrologic Controls

Other remedial measures implemented at the site to protect surface water and isolate the waste rock pile include: 1) construction of a lined (riprap, HDPE, and culvert) drainage diversion ditch to convey upland runoff away from the waste rock to the Dolores River and to prevent infiltration into waste rock adjacent to the ditch; 2) a permanently engineered embankment (berm) which isolates the north toe of the reclaimed waste rock pile from contact with the adjacent wetland and the Sulphur Creek drainage systems that flow into the Dolores River; 3) removal of river bank waste rock to create a 50-foot vegetated buffer zone between the reclaimed waste rock pile and the Dolores River; 4) compaction of 12 inches of waste rock surface to minimize infiltration, and; 5) placement of flood protection revetment (riprap) along the river side toe of the reclaimed waste rock pile to protect against Dolores River channel encroachment and flood flows up to and including the 500-year design flood event for the Dolores River.

Request for Permit Termination

ARCO requests that the criterion for successful revegetation be revised for the Silver Swan Mine to that previously submitted by the Company. ARCO also requests that the Department terminate the

existing permit based on the plant and rock fragment cover values measured on site, observed stability of the site surface, and the construction of other significant hydrologic controls.

Color Photo(s)

The following pages contain color that does not appear in the scanned images.

To view the actual images, please contact the Superfund Records Center at (303) 312-6473.

PHOTO LOG OF THE SILVER SWAN MINE

Photos Taken September 9, 1998

Photo #	Description
1	Looking west-southwest across the north top and north slope of the revegetated waste pile.
2	Looking north-northwest across the wetlands near the northern border of the project area.

1998 RICO Project Revegetation Success

CEDAR CREEK ASSOCIATES, INC.

Sampling Area: Silver Swan - Wetland   9/9/98

S. Viert   Point Intercept Ground Cover

Sample No.-->	1	2	3	4	5	1	2	3	4	5
Grass										
Agrostis alba	28	43	41	60	42					
Poa ampla	6		2	2		卌		||	||	
Festuca sp.	3		5	2		|||		卌	||	
Trifolium repens										
Bromus carinatus			8					卌 |||		
Agropyron dasystachyum					48					
0 10 0 0										
Forbs										
Barophytes		2					||			
Melilotus officinalis			1					/		
Epilobium ciliata					1					
unidentifiable										
Shrubs										
water	0	14	0	0	0					
T.P. Cover	36	45	57	64	91					
Rock	53	27	14	28	0					
Litter	11	4	12	3	9					
Bare ground	0	10	17	5	0					
100%	✓	✓	✓	✓	✓					

Transect #1 in lower wetland to north near river (gen. remarks)
" #2 outfall of pond below the Transect #1 area
Transect #3 at the east edge of the dump slope
" " " " " " " " " " "
Transects 3 & 4 not real wetlands by design but Ag alba / was seeded and dominates
Transect 5 = at NW of pond in Ag alba area (wetland)
3+4+4+3

Incidentals:

Fireweed, Salix (planted cuttings), Euphorbia ciliata, Hoja, Popr, Phleum pratense

1998 RICO Project Revegetation Success

CEDAR CREEK ASSOCIATES, INC.

Sampling Area: Silver Swan Upland — 9/9/98

S. Viert — **Point Intercept Ground Cover**

Sample No.-->	1 (N Face)	2 (E Face)	3 (E Flat)	4	5	1 (N Face)	2 (E Face)	3 (E Flat)	4	5
Grass										
Bromus carinatus	35	14	7	18	3					
Agropyron dasystachyum	2	1	1	2	3	||	|	|	||	|||
Ag. trachycaulum	2	7	15	9	10	||	卌 ||	卌 卌 卌		
Festuca ovina		3	2		1		|||	||		|
Bromus tectorum		1					|			
Hordeum jubatum			1					|		
Poa compressa			4					||||		
Agrostis			3					|||		
A. spicatum					7					卌 ||
Poa ampla					1					|
Forbs										
Penstemon strictus	2	1	1			||	|	|		
Linum lewisii	1	2				|	||			
Dandelion		2					||			
Rumex crispus			1					|		
Melilotus officinalis			2		2			||		||
Astragalus cicer					1					|
Polygonum aviculare					2					||
unidentifiable										
Shrubs										
Mulch	6	12	0	0	0					
T.P. Cover	42	31	37	29	30					
Rock	24	28	38	40	44					
Litter	12	0	1	1	0					
Bare ground	16	29	24	30	26					
100%	✓	✓	✓	✓	✓					

$n = 5$
$\bar{x} = 33.8$
$s^2 = 20.7$
$n_m = 1.6$

Incidentals: Meof Viam

Lilo Oen. ther Chen Agpr Mesa

Phleum pratense Rumex crispus Ast cicer Tri pratense Lin vulgaris

Fest ovina Ag trach Cirsium arvense Lac ser Penstemon

Brea Hi.. Ag bas Tar of Art dracunculus Agrostis alba